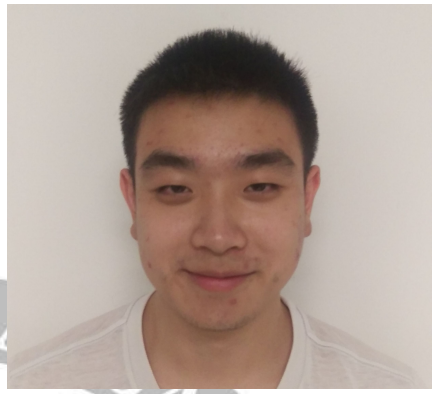
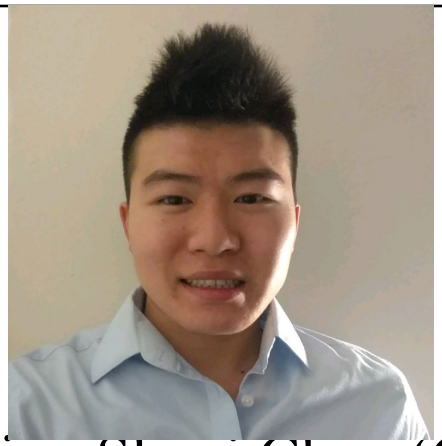
So-Lo

Team 12



Andy Weng (CSE)



Ming Shuai Chen (CSE)

Suzet Nkwaya (EE)

Dan-Michael Tiamzon (EE)

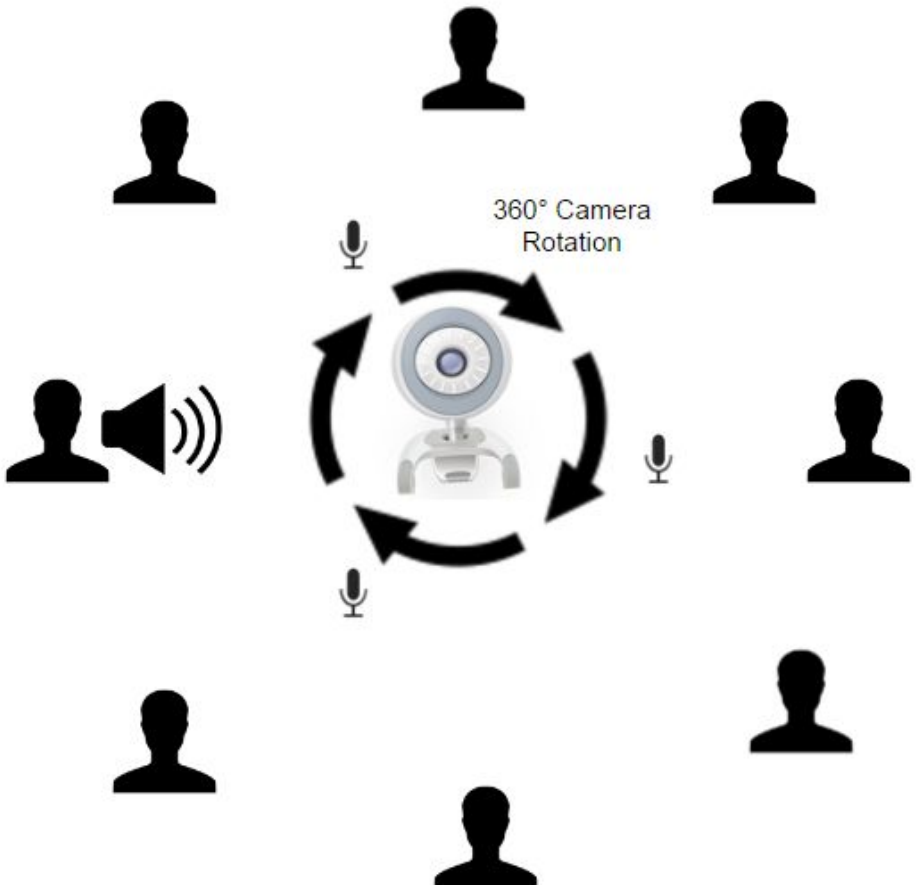
Current Problems with Recording Meetings

- Recording group meetings
  - Long meetings are full of information
  - Often meetings are recorded for audio only
  - Camera is usually in a fixed position for A/V recording

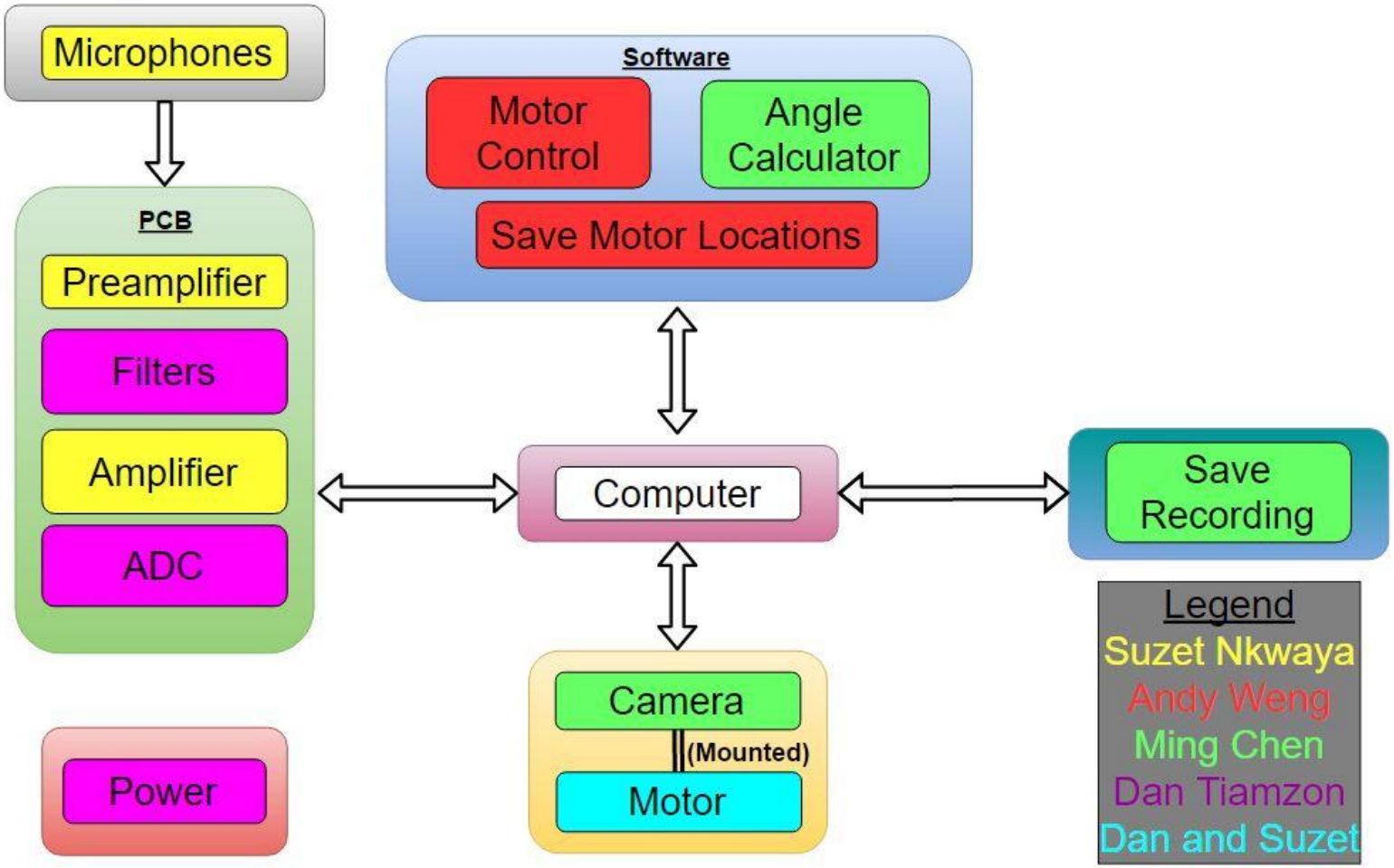
So-Lo

- Real time sound locator
- Rotating stand that points almost to the location of sound
- Effective for small to medium sized rooms
- Utilizing the right microphone sensitivity

So-Lo Diagram



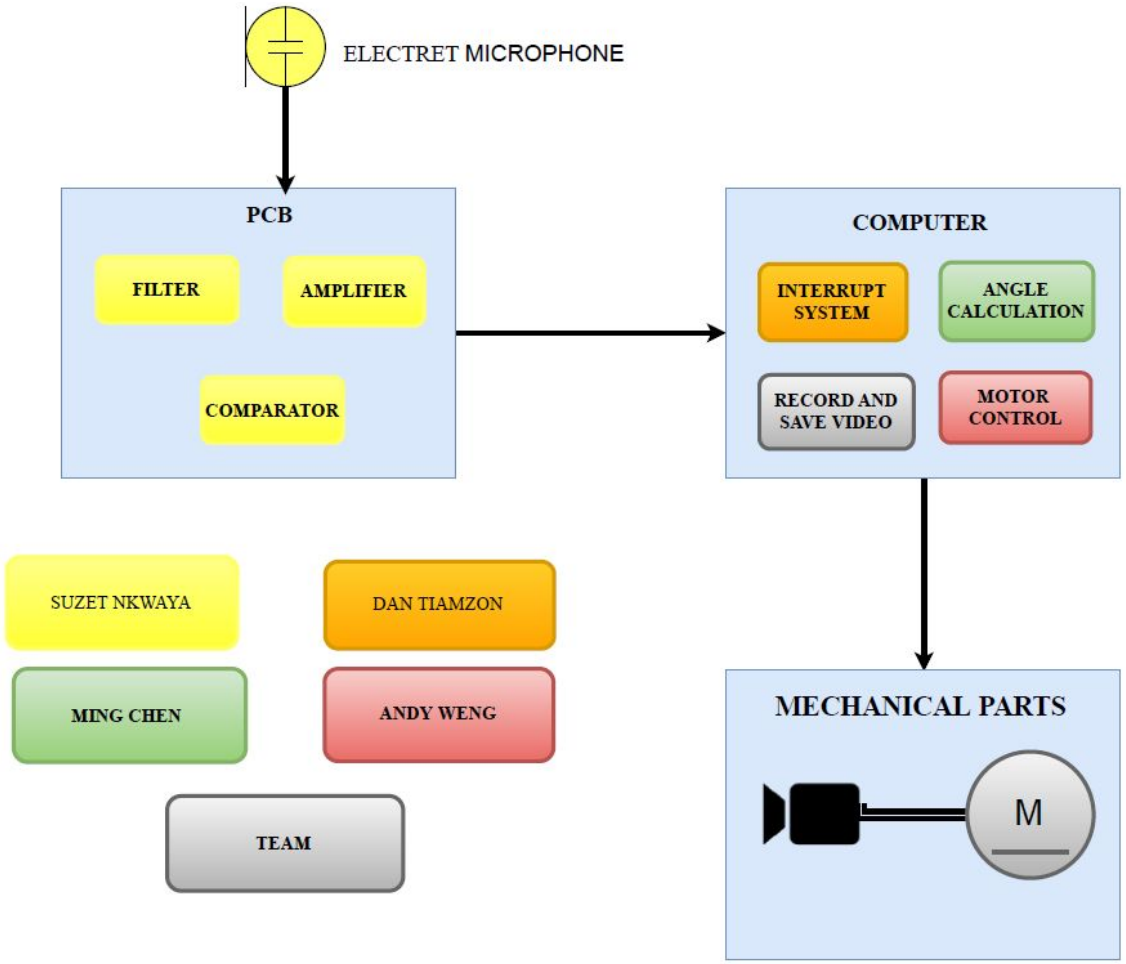
Previous Block Diagram



Changes in Implementation

- Removal of ADC
  - ADC is too slow to sample and communicate with Pi
- New Implementation
  - Much Faster
  - The amplified and filtered signal from the microphone is directed to a comparator
  - Compare the input sound to noise level
  - Produce high if sound is higher than noise level
  - Send this signal directly into the Raspberry Pi

Updated Block Diagram



MDR Deliverables (Updated)

- Mainly present the concept of sound location
  - Set-up microphone array to sense sounds. (Suzet)
  - Raspberry Pi and Python Code to determine the order of which microphones receive signals. (Dan)
  - Code which implements TDOA using the order of microphones and estimate sound source location angle. (Ming)
  - Control rotation angle of the motor. (Andy)
- No implementation of video recording and saving.
  - Does not present the concept of sound locating.

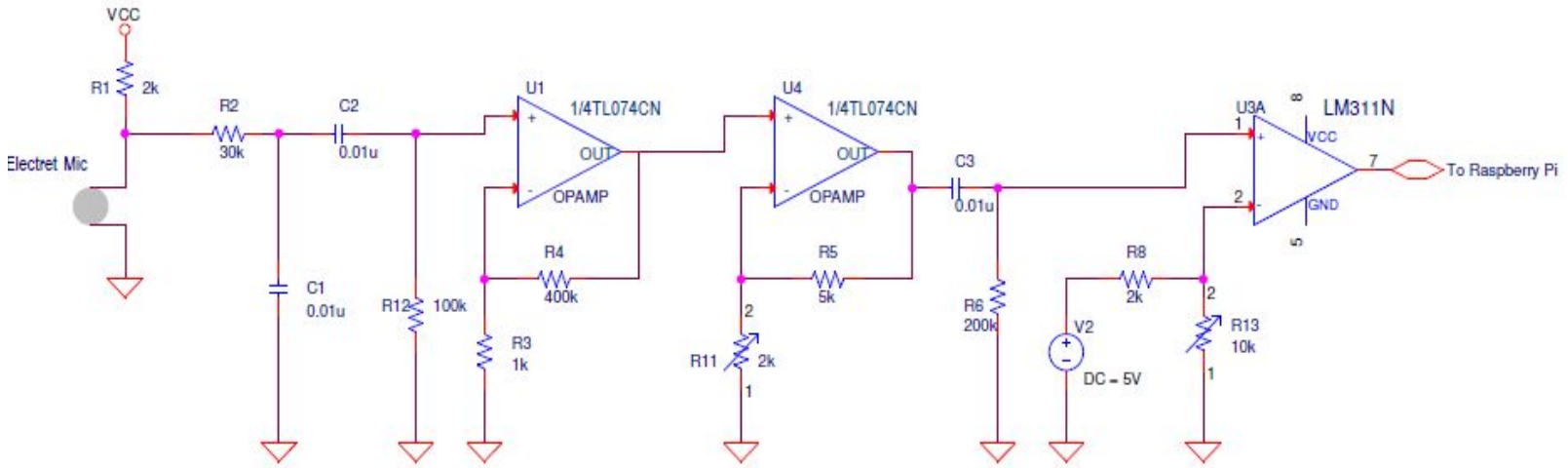
System Requirements

- Calculate source of sound based on time differences between microphones located at a known position.
- Microphone Array
  - amplify voice and filter out noise.
    - Amplifier : TL074 CN
    - Filter : Bandpass 100Hz-500Hz
    - Comparator: LM 311N

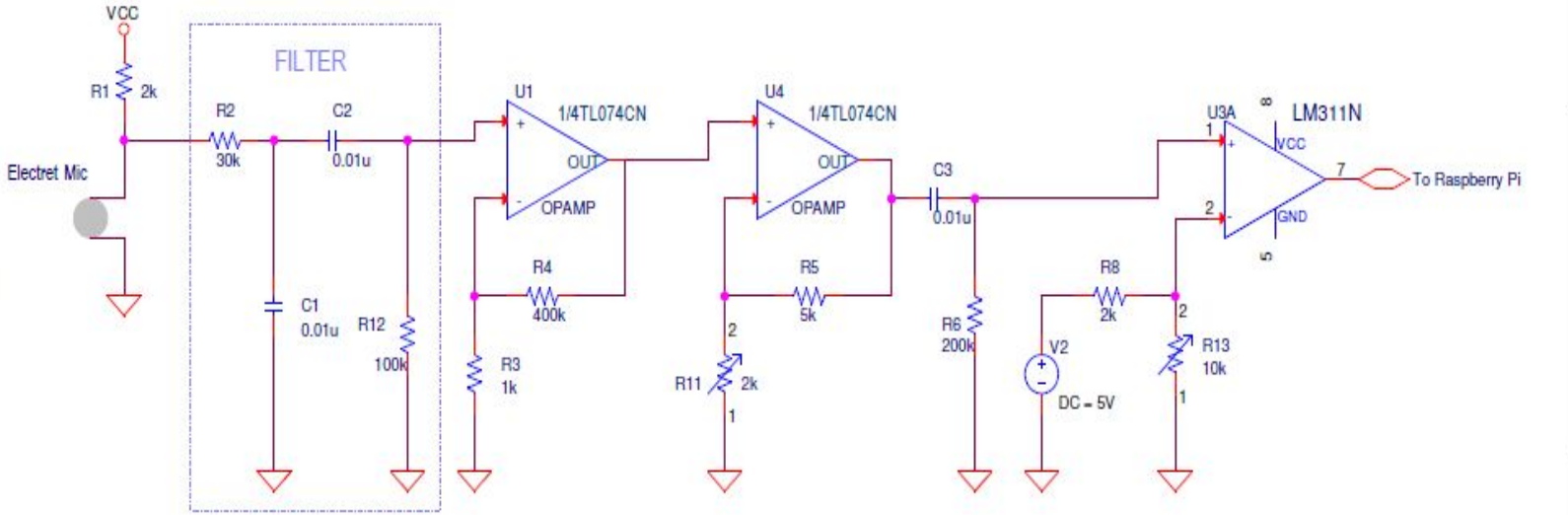
System Requirements

- Raspberry Pi
  - use microphone array outputs to calculate sound source location
- Motor
  - Receive commands from Raspberry Pi
- Camera
  - Record video and save data on SD

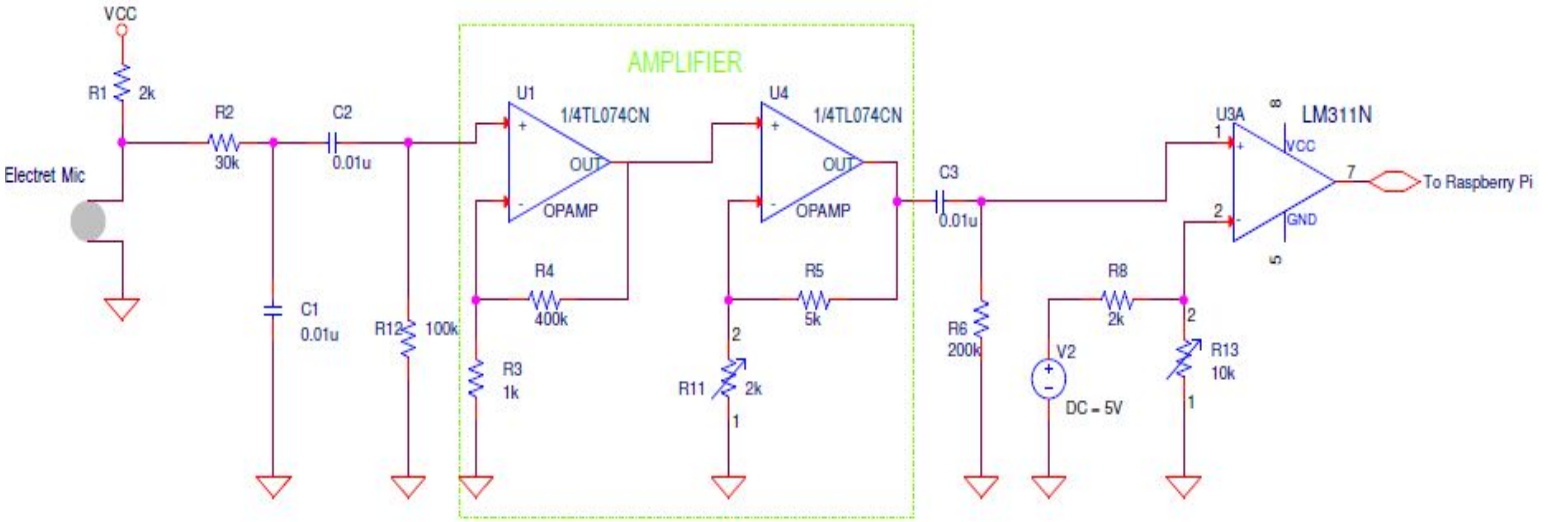
Microphone Array Circuit



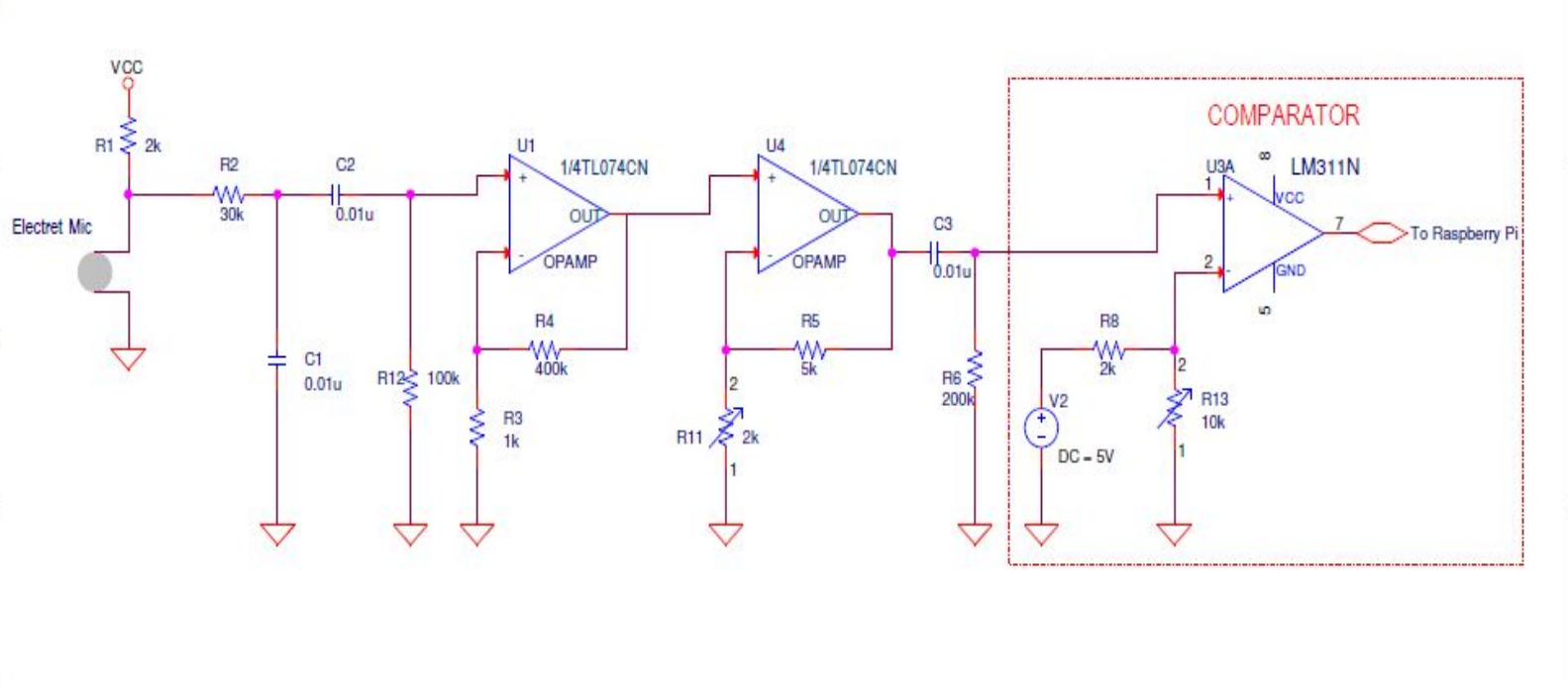
Filter


VCC
R1
2k
FILTER
R2
30k
C2
0.01u
Electret Mic
C1
0.01u
R12
100k
U1
1/4TL074CN
OUT
OPAMP
R4
400k
R3
1k
U4
1/4TL074CN
OUT
OPAMP
R5
5k
2
R11
2k
1
C3
0.01u
R6
200k
R8
2k
V2
DC = 5V
2
R13
10k
1
U3A
LM311N
VCC
GND
To Raspberry Pi

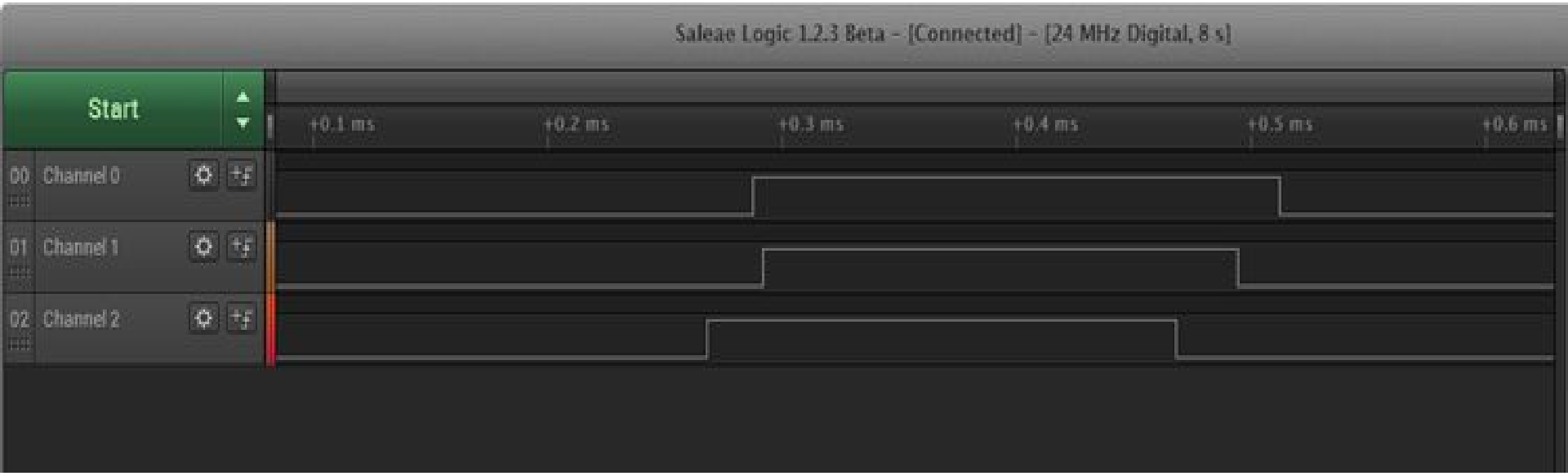
Amplifier


VCC
R1
2k
Electret Mic
R2
30k
C2
0.01u
C1
0.01u
R12
100k
AMPLIFIER
U1
1/4TL074CN
OUT
OPAMP
R4
400k
R3
1k
U4
1/4TL074CN
OUT
OPAMP
R5
5k
R11
2k
C3
0.01u
R6
200k
R8
2k
V2
DC = 5V
R13
10k
U3A
LM311N
VCC
GND
To Raspberry Pi

Comparator


VCC
R1
2k
Electret Mic
R2
30k
C2
0.01u
C1
0.01u
R12
100k
U1
1/4TL074CN
OUT
OPAMP
R4
400k
R3
1k
U4
1/4TL074CN
OUT
OPAMP
R5
5k
R11
2k
C3
0.01u
R6
200k
COMPARATOR
U3A
LM311N
VCC
GND
To Raspberry Pi
R8
2k
R13
10k
V2
DC = 5V

Time Difference of Arrival



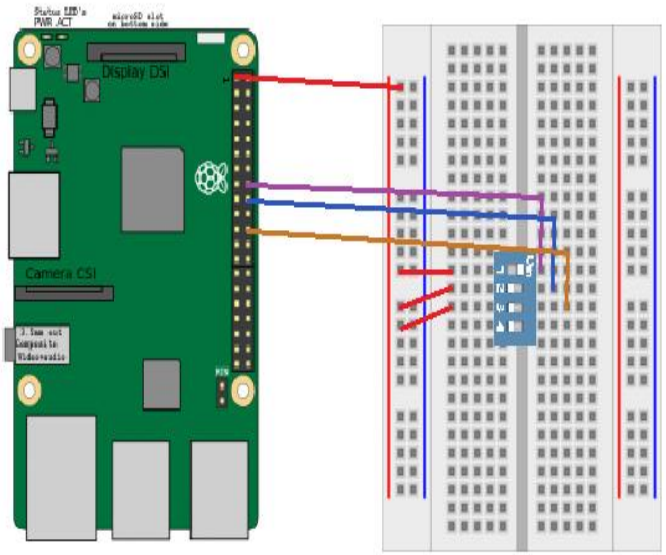
- TDOA of 3 microphones analyzed on a Logic Analyzer

Interrupt System

Software that detects for interrupts on the Raspberry Pi GPIO channels.

- Software is written in Python.
- Input = Voltage produced by microphone system.
- Output = Order in which the microphones received a signal and the time differences between the 1st & 2nd microphones and the 1st & 3rd microphones.
- Output will be sent to the software which calculates the angle in which the sound originated from.

Interrupt System

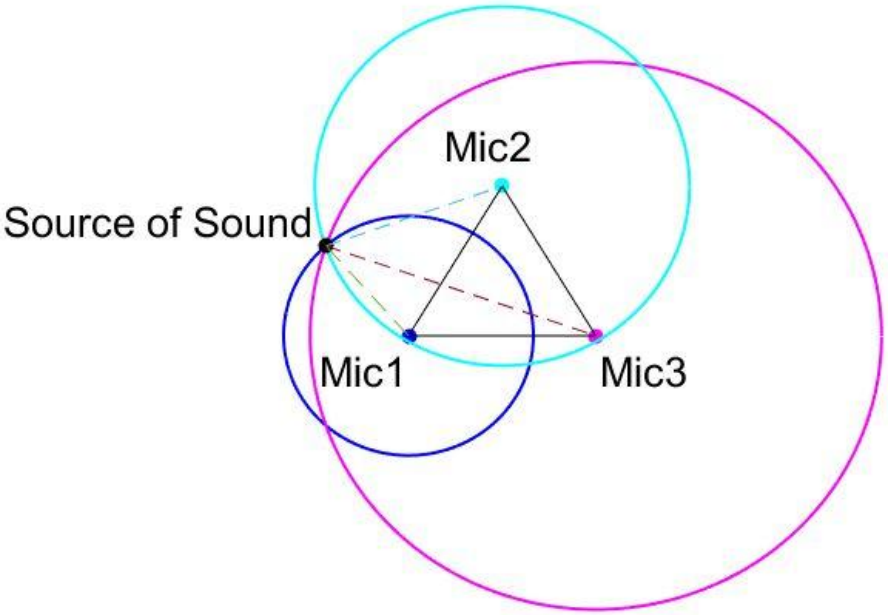


- Setup 3 GPIO pins to detect events. Events to be detected is a voltage.
- Connect the 3 GPIO pins to terminals of a 4 Pin Dip Switch.
- 3.3V Pin from Pi connected to other terminals of Dip Switch.
- Flip all switches at the same time closely.
- Code marks which channel receives a voltage first and marks the time that voltage arrived.
- Code keeps track of the order of arrival and solve the time differences.

TDOA (Time Difference of Arrival)

TDOA utilizes the equation of a circle to pinpoint the source.

Equation of a circle: $(x - h)^2 + (y - k)^2 = r^2$



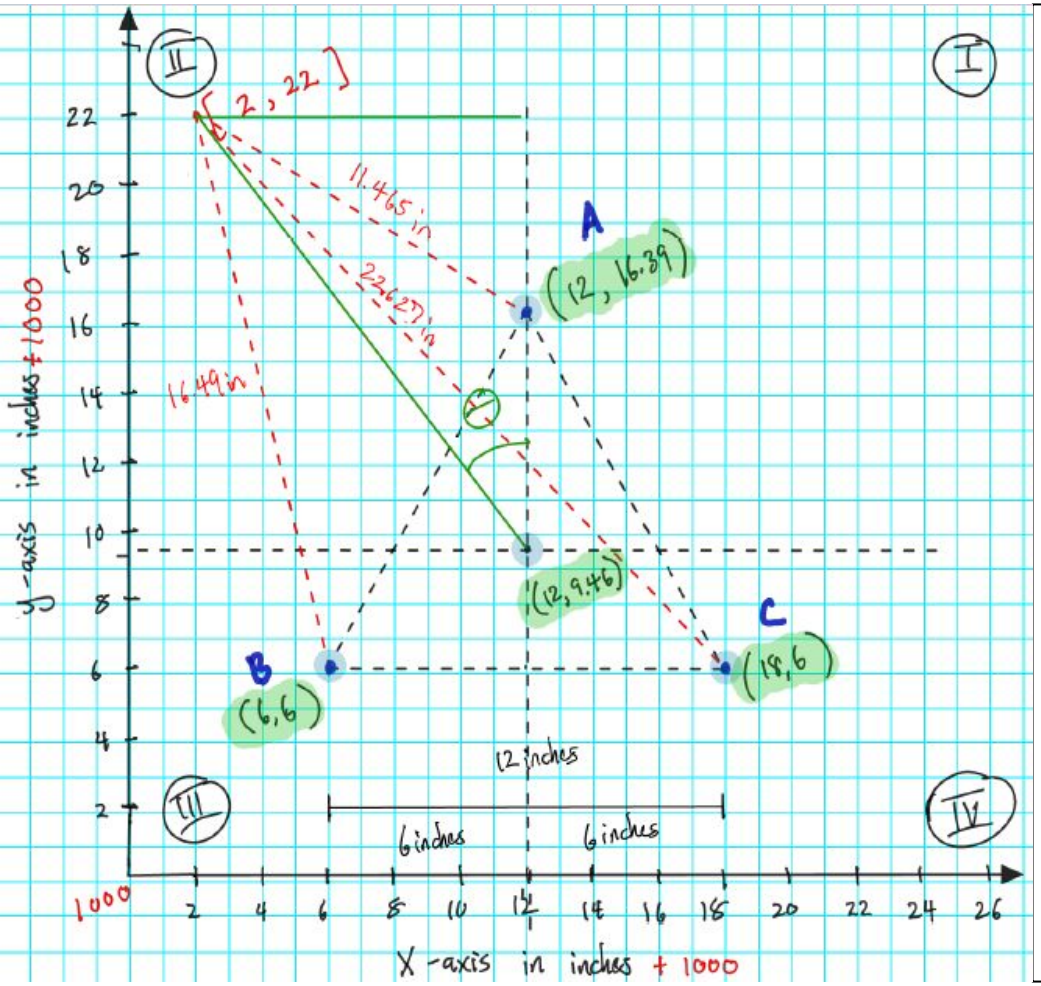
$$(a_x - x_0)^2 + (a_y - y_0)^2 = r^2$$

$$(b_x - x_0)^2 + (b_y - y_0)^2 = (r + 346 b_s)^2$$

$$(c_x - x_0)^2 + (c_y - y_0)^2 = (r + 346 c_s)^2$$

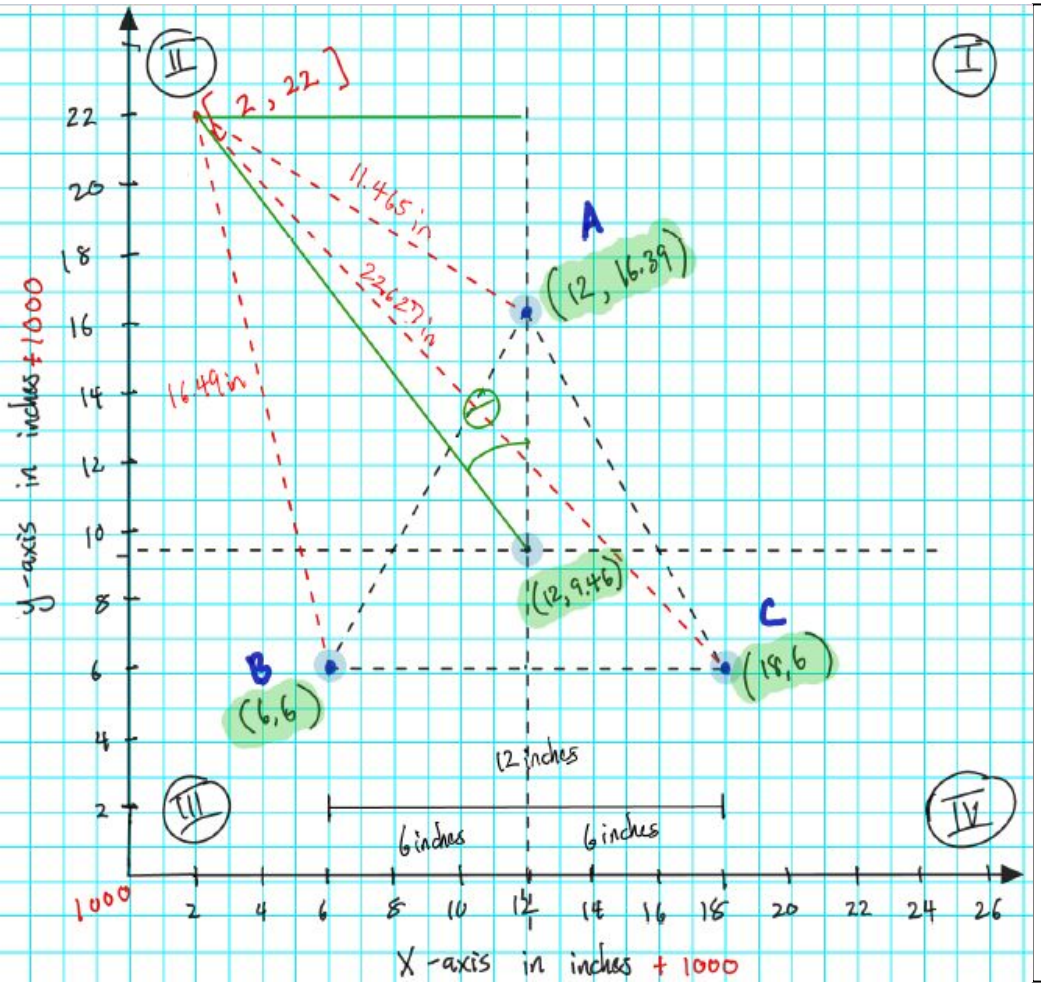
346 m/s => 13622 inches/sec

Implementation of TDOA in Python



»Origin at x=1000, y=1000

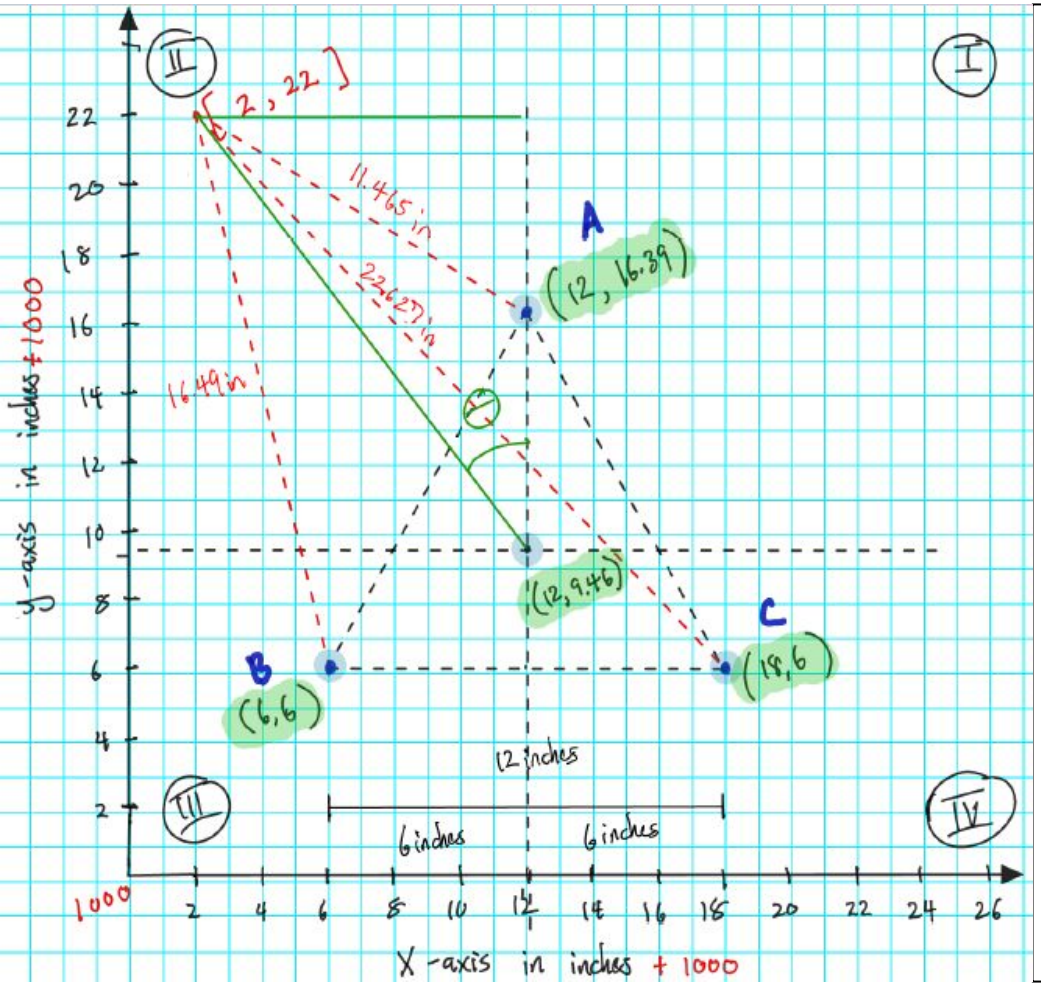
Implementation of TDOA in Python



»Origin at x=1000, y=1000

»Microphones are set up roughly 12 inches apart.

Implementation of TDOA in Python

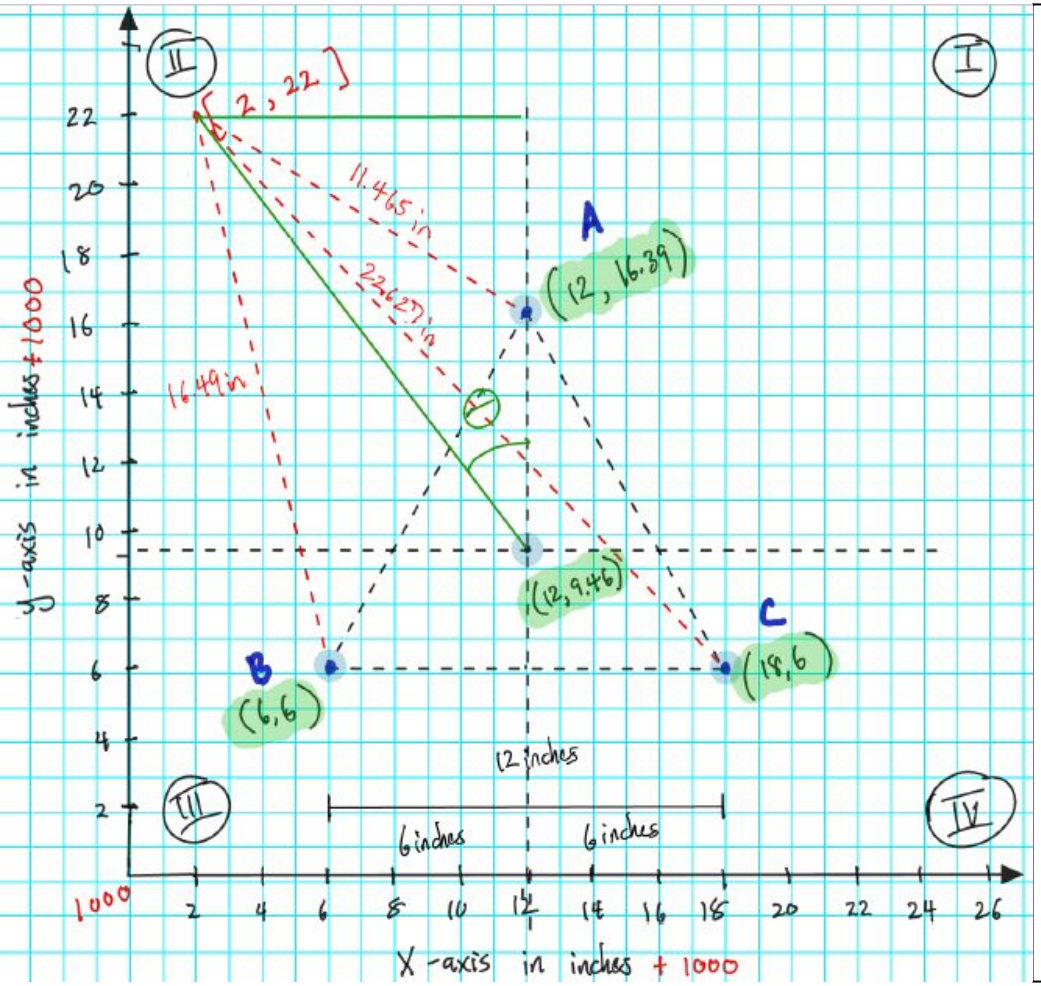


»Origin at x=1000, y=1000

»Microphones are set up roughly 12 inches apart.

»Program takes in x pos and y pos of the speaker.

Implementation of TDOA in Python



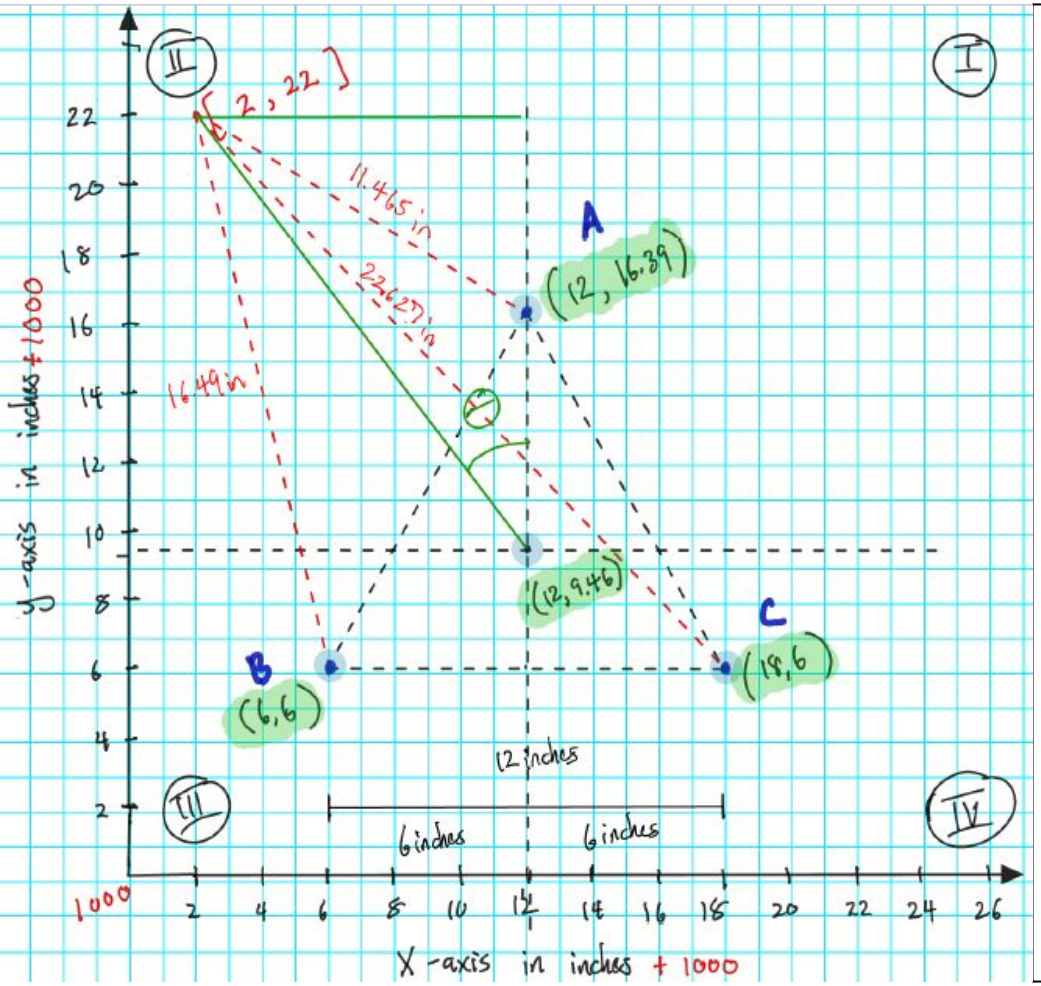
»Origin at x=1000, y=1000

»Microphones are set up roughly 12 inches apart.

»Program takes in x pos and y pos of the speaker.

»Calculates the time bs and cs, time of second and third order microphone.

Implementation of TDOA in Python



»Origin at x=1000, y=1000

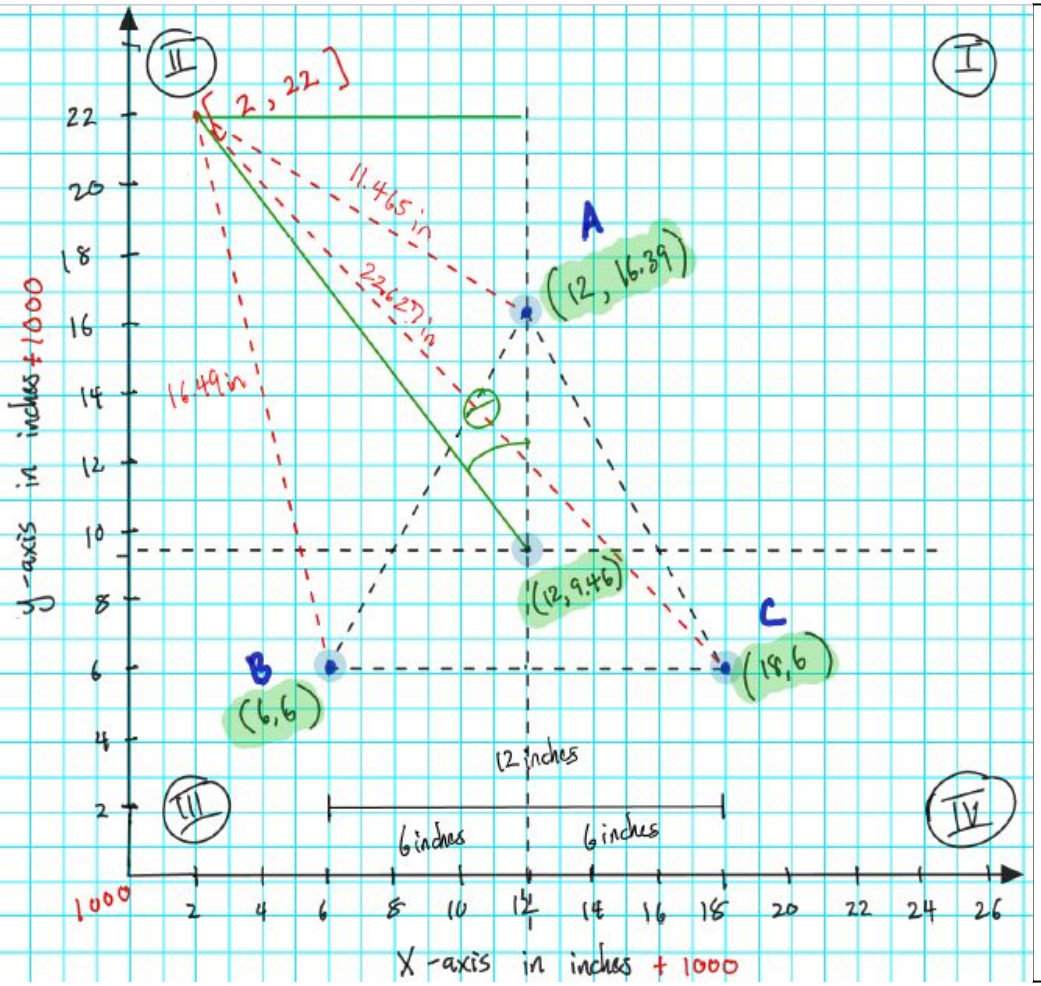
»Microphones are set up roughly 12 inches apart.

»Program takes in x pos and y pos of the speaker.

»Calculates the time bs and cs, time of second and third order microphone.

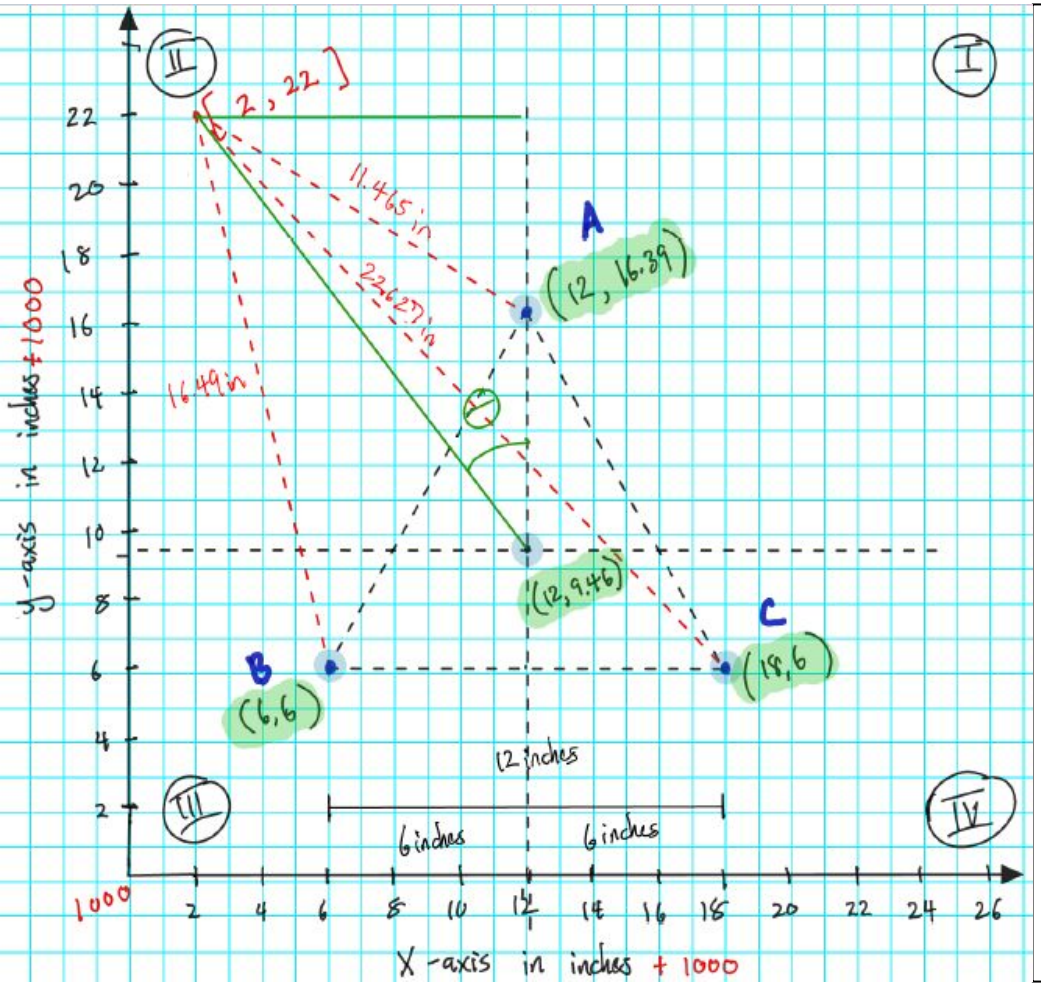
»Program outputs calculated x and y position.

Implementation of TDOA in Python



- »Origin at x=1000, y=1000
- »Microphones are set up roughly 12 inches apart.
- »Program takes in x pos and y pos of the speaker.
- »Calculates the time bs and cs, time of second and third order microphone.
- »Program outputs calculated x and y position
- **»This should match our input**

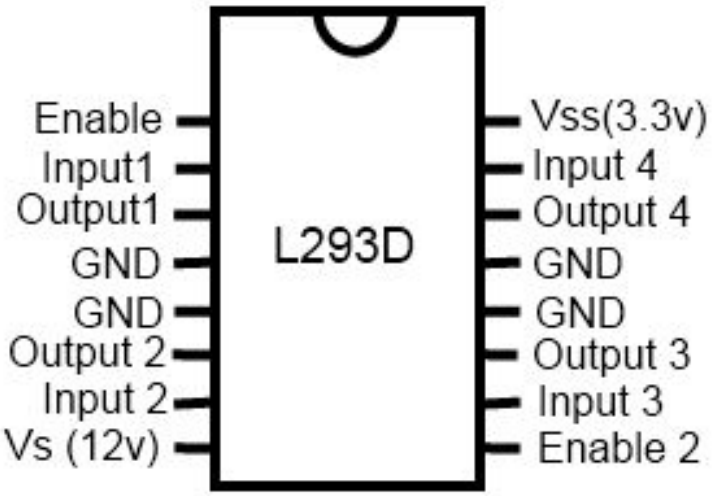
Implementation of TDOA in Python



- »Origin at x=1000, y=1000
- »Microphones are set up roughly 12 inches apart.
- »Program takes in x pos and y pos of the speaker.
- »Calculates the time bs and cs, time of second and third order microphone.
- »Program outputs calculated x and y position
- »This should match our input
- **»Angle is calculated**

L293D Motor Driver

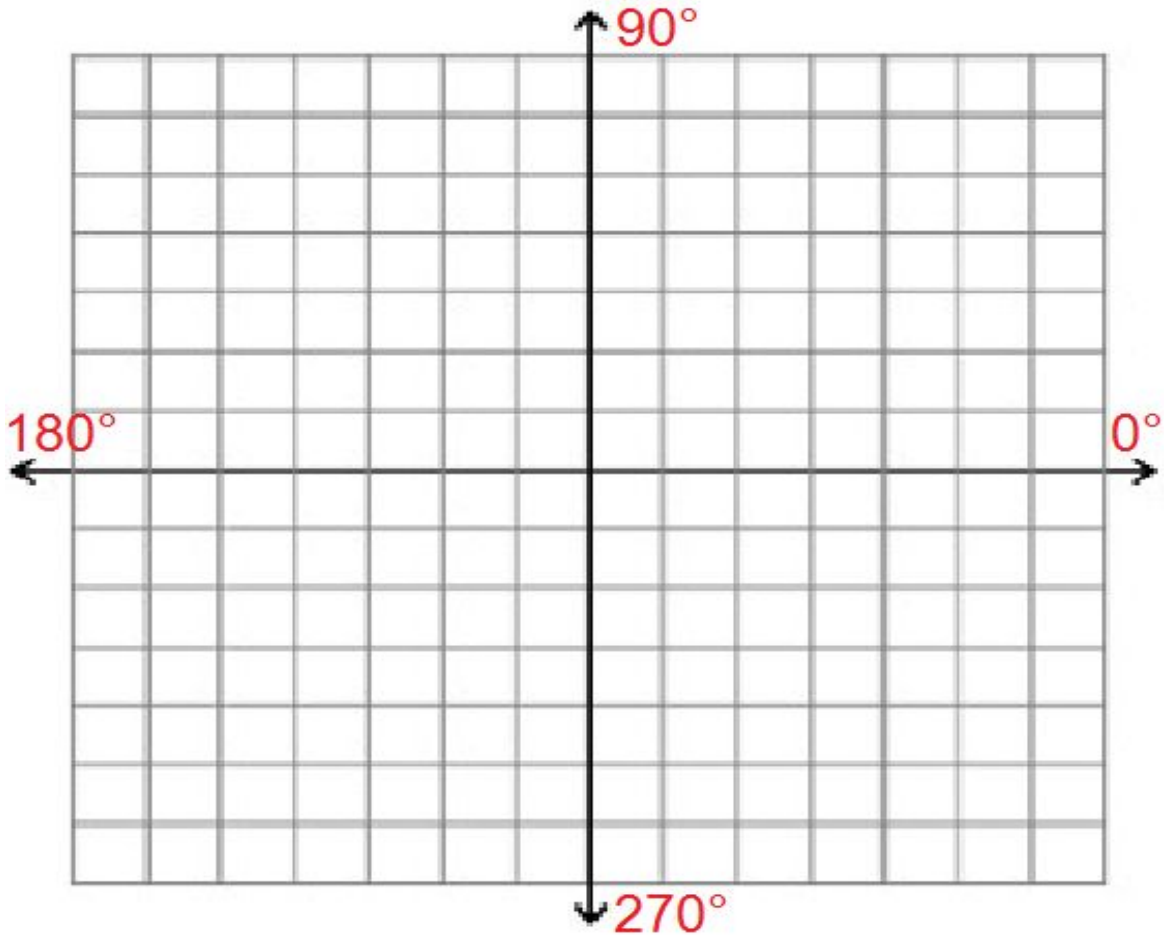
- Raspberry Pi not capable of driving the motor we are using
- Capable of driving two motors (only one is used)
- Allows us to control the direction the motor spins by reversing the current going through the motor



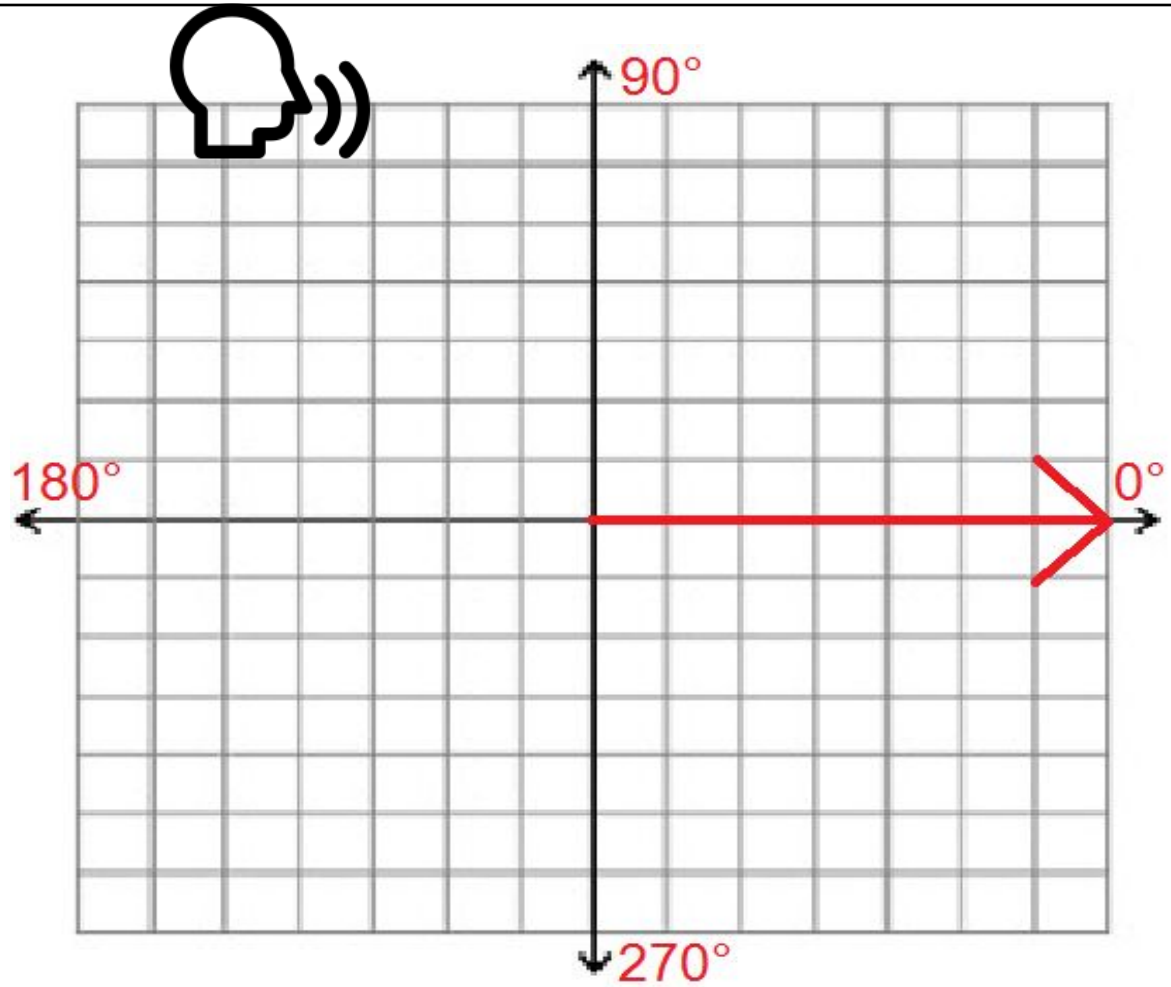
The Encoder

- 5 pins - Vcc, Gnd, A, B, Index
- Only used A channel
- Disc connected to a shaft that is also connected to the motor
- When the disc spins, channel A outputs a series of pulses

Implementation of the Motor



Implementation of the Motor



Implementation of the Motor

Proposed CDR Deliverables

- Demonstration of Complete System Functionality (Team)
- Place the microphone arrays in an equilateral triangle.
- Detect voice from 3 feet away (Suzet)
- Motor will respond and turn to the angle produced by the angle calculator (Andy & Dan)
- Record and store 30 second video on SD card (Ming)

Microphone Demo (backup)